

**What is claimed is:**

1. A method for labeling synthesis, comprising:
  - 5 (a) providing a UV reactor assembly comprising a high pressure reaction chamber, a UV lamp and a concave mirror, wherein the high pressure reaction chamber having a window facing the concave mirror, a liquid inlet and a gas inlet in a bottom surface thereof,
  - (b) providing a reagent volume to be labeled,
  - 10 (c) introducing a carbon-isotope monoxide enriched gas-mixture into the reaction chamber of the UV reactor assembly via the gas inlet,
  - (d) introducing at high pressure said reagent into the reaction chamber via the liquid inlet,
  - (e) turning on the UV lamp and waiting for a predetermined time while the  
15 labeling synthesis occur, and
  - (f) removing the labeled product from the reaction chamber.
2. A method of claim 1, wherein the carbon-isotope monoxide enriched gas-mixture is produced by a method comprising:
  - 20 (a) providing carbon-isotope dioxide in a suitable carrier gas,
  - (b) converting carbon-isotope dioxide to carbon-isotope monoxide by introducing said gas mixture in a reactor device,
  - (c) trapping carbon-isotope monoxide in a carbon monoxide trapping device, wherein carbon-isotope monoxide is trapped but not said carrier gas, and
  - 25 (d) releasing said trapped carbon-isotope monoxide from said trapping device in a well defined micro-plug, whereby a volume of carbon-isotope monoxide enriched gas-mixture is achieved.
3. A method of claim 1, wherein the carbon-isotope is  $^{11}\text{C}$ ,  $^{13}\text{C}$ , or  $^{14}\text{C}$ .  
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4. A method of claim 1, wherein the carbon-isotope is  $^{11}\text{C}$ .

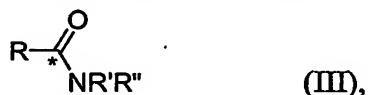
5. A method of claim 1, wherein the step of introducing the reagent is performed using a pressure that is about 80 times higher than the pressure before the introduction, in order to maintain a pseudo one-phase system.
- 5 6. A method of claim 1, wherein the step of waiting a predetermined time comprises stirring in the reaction chamber to enhance the labeling synthesis.
7. A method of claim 7, wherein the step of waiting a predetermined time further comprises adjusting the temperature of the reaction chamber so that the labeling  
10 synthesis is enhanced.
8. A system for labeling synthesis, comprising:
- (a) a UV reactor assembly comprising a high pressure reaction chamber,
  - (b) a UV lamp, and
  - 15 (c) a concave mirror,
- wherein the high pressure reaction chamber having a window facing the concave mirror, a liquid inlet and a gas inlet in a bottom surface thereof, wherein the concave mirror can focus the UV light from the UV lamp, and the focused light beam enters the window of the reaction chamber.
- 20 9. A system of claim 8, further comprising a motor, a magnet, and a magnetic stirring bar inside the reaction chamber.
10. A system of claim 8, wherein the window is a sapphire window.
- 25 11. A system of claim 8, further comprising a protective housing and a bench where the reaction chamber, UV lamp and the concave mirror can be mounted.

12. A method for radiocarbonylation comprising reaction of carbon-isotope monoxide with a compound of formula (I) and a compound of formula (II):

RI (I)



5 to give a labeled compound of formula (III):



wherein R is linear or cyclic lower alkyl or substituted alkyl, aryl or substituted aryl and R' and R'' are independently H, linear or cyclic lower alkyl, or substituted alkyl, aryl or substituted aryl.

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13. A method of claim 12, wherein R may contain hydroxyl, alkoxy, chloro, fluoro, amino or carboxy groups.

14. A method of claim 12, wherein R' and R'' may contain hydroxy, amino, alkoxy, chloro or fluoro groups.

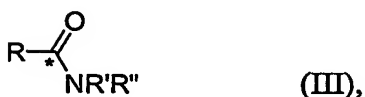
15. A method of claim 12, wherein the carbon-isotope monoxide is [<sup>11</sup>C] monoxide.

16. A carbon-isotope labeled compound of formula (III),



wherein R is linear or cyclic lower alkyl or substituted alkyl, aryl or substituted aryl and R' and R'' are independently H, linear or cyclic lower alkyl, or substituted alkyl, aryl or substituted aryl.

25 17. A kit for PET study comprising a carbon-isotope labeled compound of formula (III),



wherein R is linear or cyclic lower alkyl or substituted alkyl, aryl or substituted aryl and R' and R'' are independently H, linear or cyclic lower alkyl, or substituted alkyl, aryl or substituted aryl.